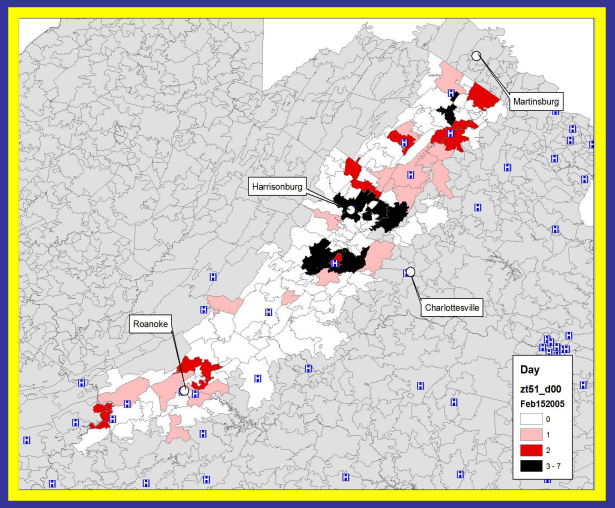
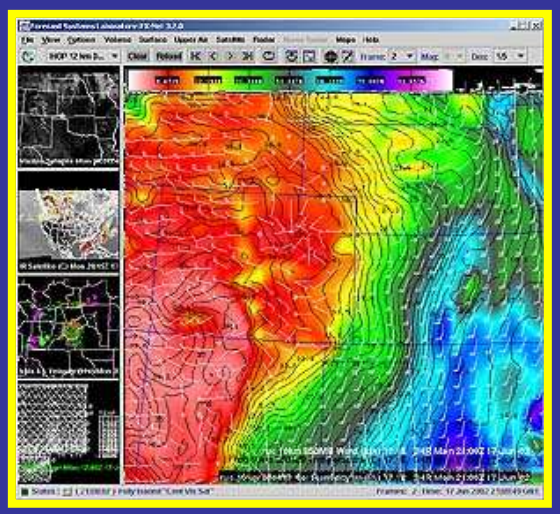
SHENAIR
Science Team Progress Report





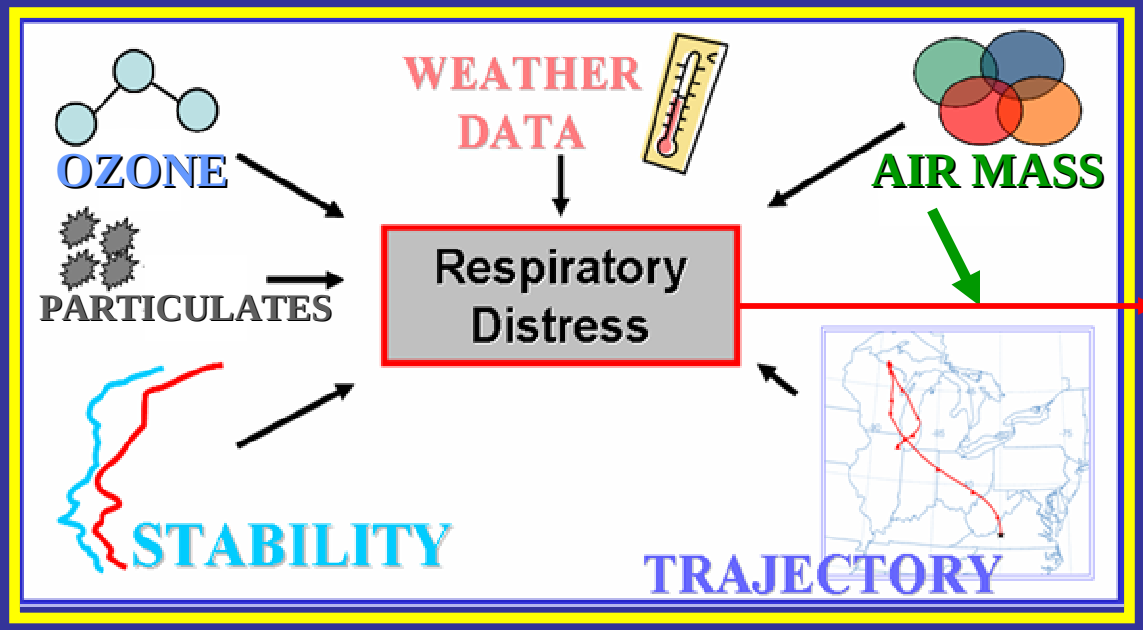
February 2, 2009

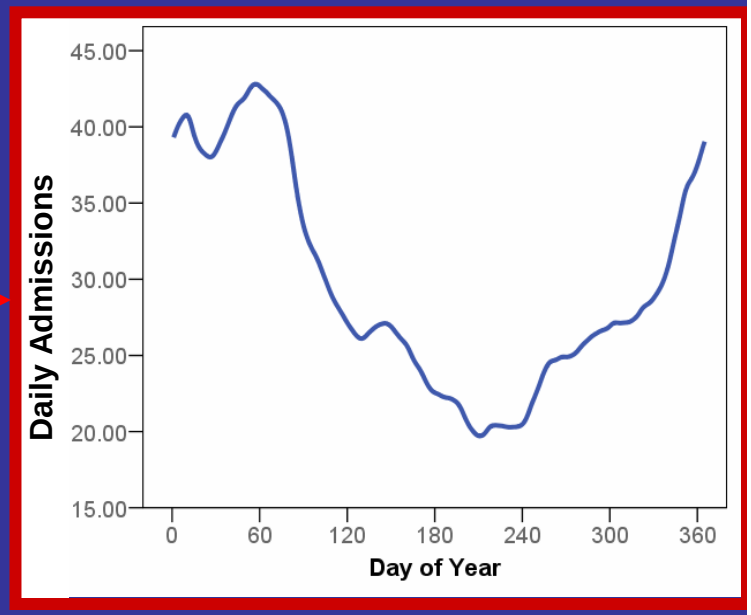
1. Advances Toward a Respiratory Health Alert Model

UVa SHENAIR Team

Prof. Robert Davis, Dr. Kyle Enfield, Steve Gawtry, Dave Hondula, David Knight, Caroline Normile, Luke Sitka, Jerry Stenger

Building the Model





Dependent Variable

- Daily hospital admissions

"Average" daily hospital admissions

Independent Variables

- Weather and pollution variables representative of outdoor conditions that may influence respiratory well-being

Analysis of Air Pollution Data

Example Finding: The impact of warm moist (tropical) air masses on ozone partly depends on the air's trajectory into the Shenandoah Valley

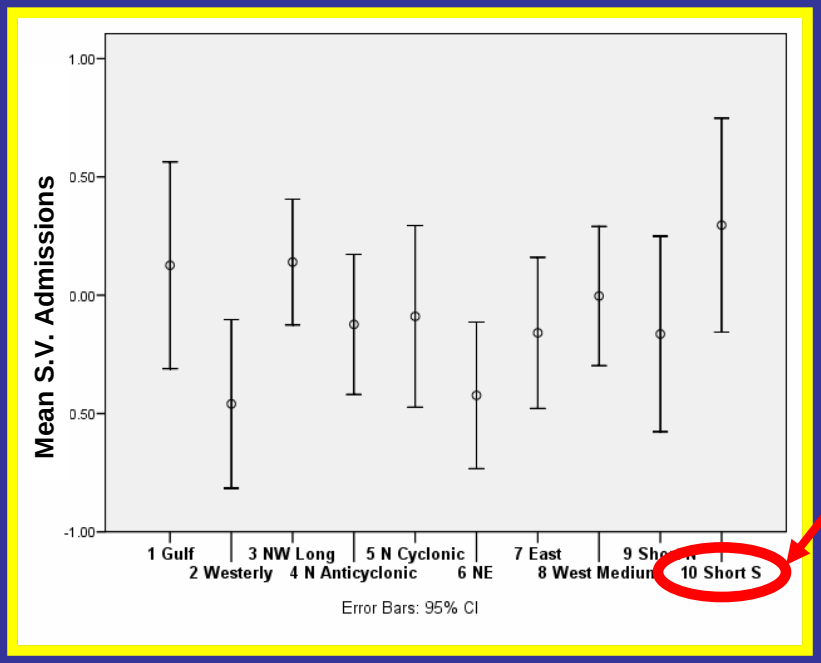
Similar analysis for other pollutants

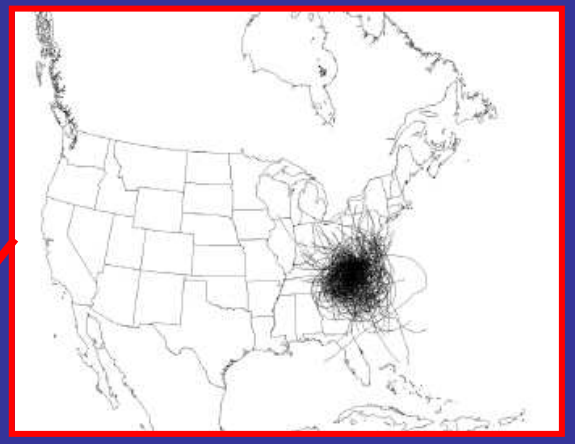
- Sulfur dioxide
- Carbon monoxide
- Small-diameter particulates (PM2.5)
- Large-diameter particulates (PM10)

Folding pollution into respiratory model

- Use forecasted pollutant levels
- Use atmospheric stability indices to determine the atmosphere's tendency to concentrate or vent pollutants

Preliminary Model Results



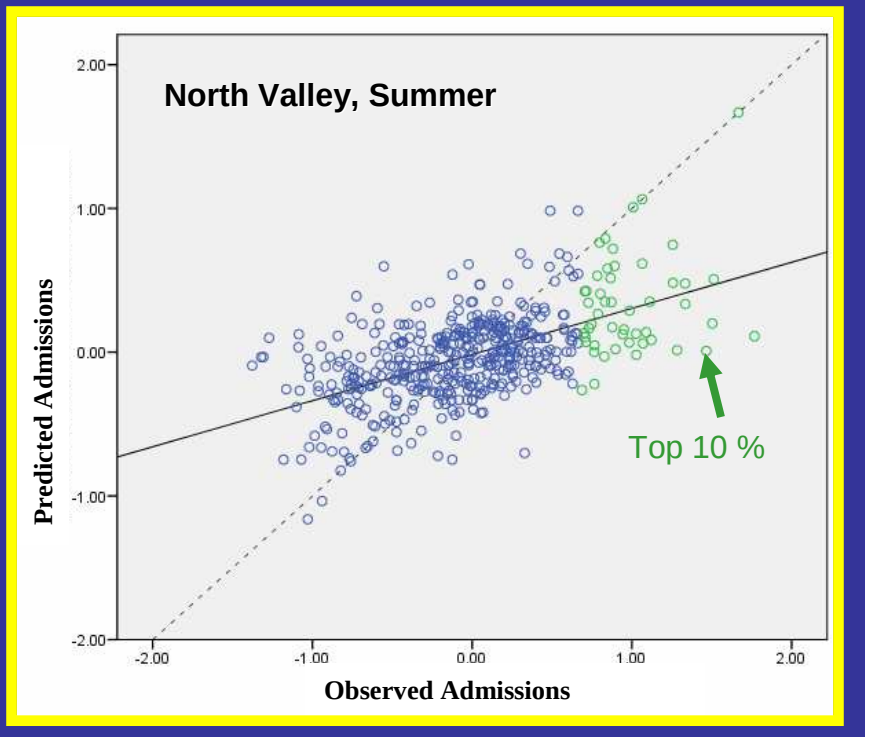


Trajectories vs. Admissions

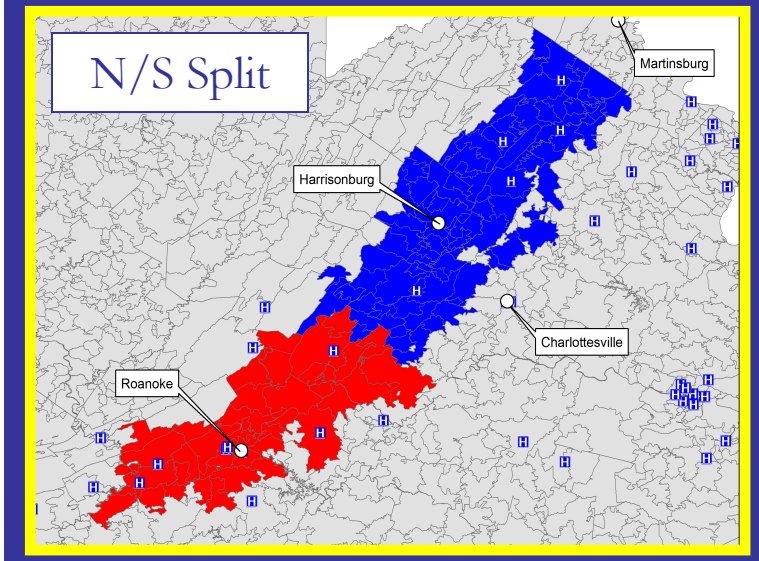
- Short back-trajectories associated with stagnating air have highest mean admissions

Simple Model for North Valley

- Using air mass and trajectory clusters as predictors has some predictive ability



Spatial Analysis of Admissions



General Summary (2000 U.S. Census Data):

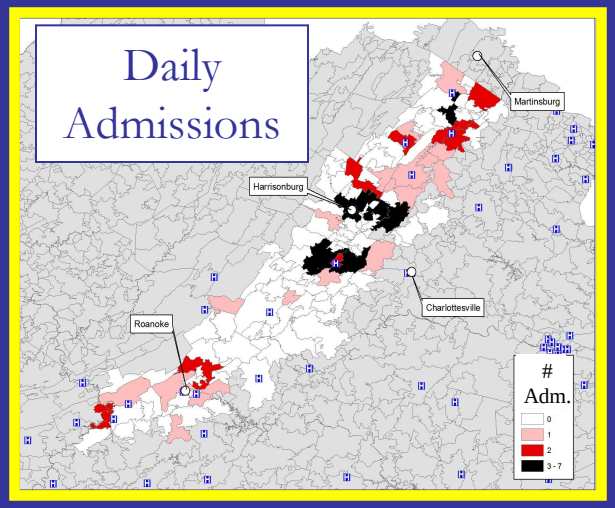
North is wealthier, less diverse racially, younger, more rural than the South

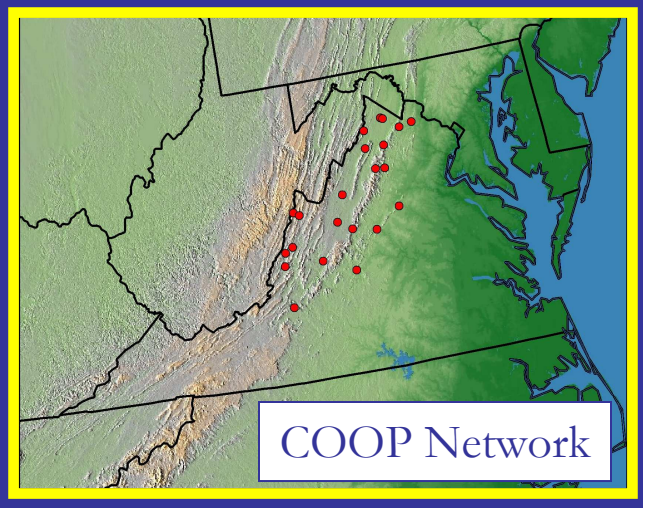
Demographics Regression Analysis

- Demographics account for approx 40-50% of the spatial variability in respiratory admissions
- In general:
  - As there are more elderly, admissions rise
  - As the level of higher education increases, admissions fall
  - Incomes > $75 K /yr, admissions rise

Daily Admissions Maps

- Current question—to what extent do weather variations within the Valley account for spatial admissions variations?





Future Work

- Include stability indices and additional pollutants as predictors in respiratory model
- Examine relationships between additional pollutants and trajectories/air masses
- Complete spatial analysis of admissions to determine zip-code level relationships between admissions and weather, demographics, and various pollution-control strategies
- Finalize respiratory model for each season for the North and South Valley
- Test and refine models

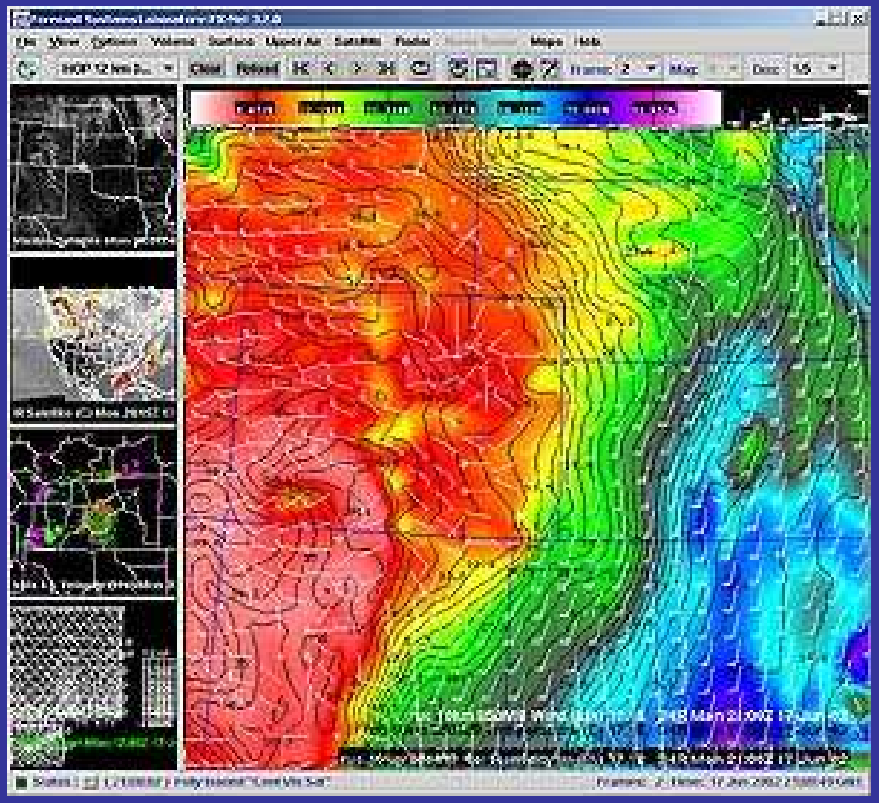
2. Exploration of Academic Applications of FX-Net

JMU SHENAIR Team

Prof. Amy Richert, Prof. Eric Pyle, Craig Ramseyer, Katie Blessing

Two Applications of FX-Net

- Design course components using FX-Net
- Investigate undergraduate research using FX-Net



Course Components

- Each student was provided questions
- Instructional Pathways were defined to answer those questions;
- Exploratory Learning through FX-Net.

Ex: Strand 1- The Naive Student

Questions	Background Knowledge/Vocabulary	References/Page #s	FX-NET component	User Manual Reference
1. What is the difference between radar and Doppler radar and how are they used in the study of weather?	- RADAR (radio detection and ranging) is a remote sensing tool that uses microwaves to determine the location, movement, height and intensity of precipitation - Doppler RADAR is the same concept of radar except it measures the movement of precipitation and particles within storms -we can use both of these to predict how intense and dangerous storm systems will be -we can also track and predict the movement of these storms **For more info see**: Doppler Effect, radar echoes, water vapor satellite imagery	Weather Studies: An Introduction to Atmospheric Science p. 13-15	Satellite Data Radar Data	p. 56-61 p. 62-65
2. How do you predict long term weather?			Text Browser	p. 31-34
3. Why does air temperature change so quickly bringing very different weather two different days?			Text Browser Surface Data Upper Air Data	p. 31-34 p. 44-47 p. 52-55
4. How does hail form in the summertime when it's so hot during the day?			NCEP/Hydro Data Upper Air Data	p. 48-51 p. 52-55
5. What is a sun dog and how does it form?	-result of refraction of sunlight off of high altitude cirrus clouds on same plane at 22° -cirrus clouds are made of plate-like ice crystals that lie flat due to air resistance as they fall through the atmosphere **For more info see**: stability, dry adiabatic lapse rate, moist adiabatic lapse rate	Weather Studies: An Introduction to Atmospheric Science p. 396, 397 (sun dogs) p. 168, 169 (cirrus clouds) p.	NCEP/Hydro Data Upper Air Data	p. 48-51 p. 52-55
6. How do our oceans affect our weather in the states?			NCEP/Hydro Maps	p. 48-51 p. 66-68

Course Design

- Questions used in General Education lab, Spring 2009
- References AMS *Online Weather Studies* text in conjunction with computer lab work using FX-Net
- The class is filled to capacity

Migratory Research with FX-Net

Research the use of FX-Net data for predicting migratory movements of insects, birds, and bats. Limited information is available about bat movements. Therefore, our research concentrates on use of FX-Net to investigate the influence of atmospheric conditions on butterfly and bird movements.

Monarch butterflies:
http://www.lymelandtrust.org/news

White throated sparrow:
http://www.birdsasart.com

Approach

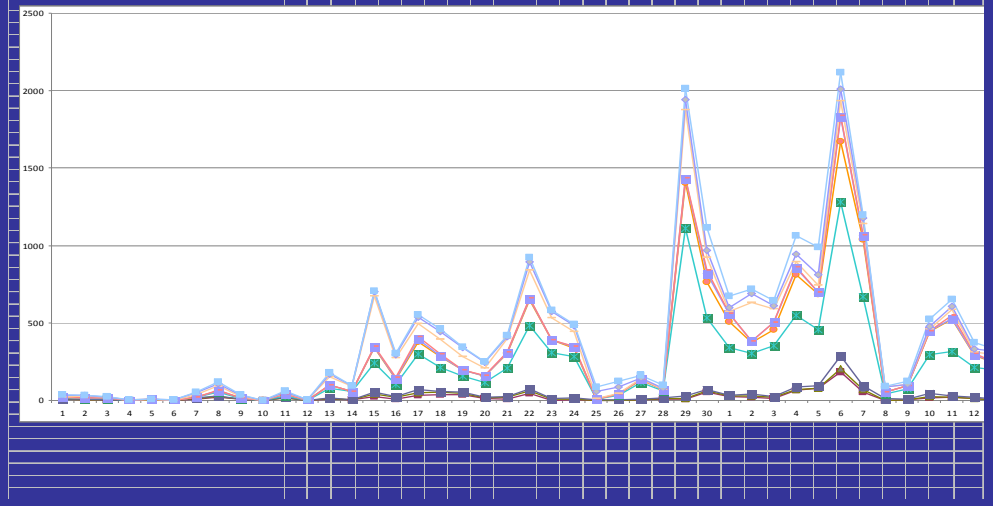
- Atmospheric conditions recorded at ground surface, including: temperature, barometric pressure, wind direction, and precipitation.
- Develop predictive model – migrations with specific weather patterns.
- Because FX-Net does not store long-term data, we archived these variables as presented by FX-Net each day during the time period that butterflies and birds tend to move through VA (Sept 1 – Dec 1).
- We utilized FX-Net for 60+ hours/month during fall migration to catalog additional data we determined as potentially important for investigating migration trends.

Sample Migration Data

- Students collected butterfly and bird stopover data in Harrisonburg from September 1 – Oct 30, 2008.
- Students collected and evaluated peak migration information from local and other regional sites.

September-October Hawkwatch Daily Counts, Cape May

	SEPTEMBER																														
DATE:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29		
Osprey	8	5	5	0	4	1	9	20	7	15	0	10	4	24	7	34	36	39	11	10	46	0	5	1	0	3	10	7			
Bald Eagle	1	1	0	0	0	0	2	6	0	2	0	3	0	19	12	17	18	6	6	9	15	7	4	0	0	2	2	4			
Northern Harrier	1	4	1	0	0	0	7	5	1	2	0	5	1	12	6	18	6	8	2	5	12	5	9	4	5	4	3	19			
Sharp-shinned Hawk	9	3	6	2	1	0	1	21	3	12	1	62	52	186	79	232	151	107	99	185	408	297	263	2	30	106	46	1079			
Cooper's Hawk	1	2	3	0	1	0	0	11	7	11	1	18	1	101	34	79	73	34	40	93	168	80	56	1	5	18	8	299			
Broad-winged Hawk	0	0	0	0	1	0	2	1	0	0	0	1	0	3	4	14	4	1	1	4	8	2	8	0	0	3	1	25			
Red-tailed Hawk	0	1	0	0	0	0	0	1	0	1	0	0	1	4	7	16	13	2	3	4	5	2	3	0	0	2	0	3			
American Kestrel	0	15	5	2	2	0	17	29	5	7	1	55	32	324	124	85	94	86	47	89	179	139	96	4	4	3	0	439			
Merlin	13	4	2	2	1	2	11	16	11	5	3	17	3	31	23	41	52	60	36	14	53	43	40	45	43	3	7	68			
Peregrine Falcon	4	0	1	0	0	1	4	9	3	6	0	7	1	3	6	19	16	4	4	8	31	6	8	31	38	17	21	71			



Numbers of raptors moving through Cape May Point during study.

3. Energy Use and Emissions Comparison of Idling Reduction Options for Heavy-Duty Diesel Trucks

JMU-ANL-UCDavis SHENAIR Team

Linda Gains, Argonne National Lab

Christie-Joy Brodrick Hartman, JMU

Matt Solomon, UC Davis

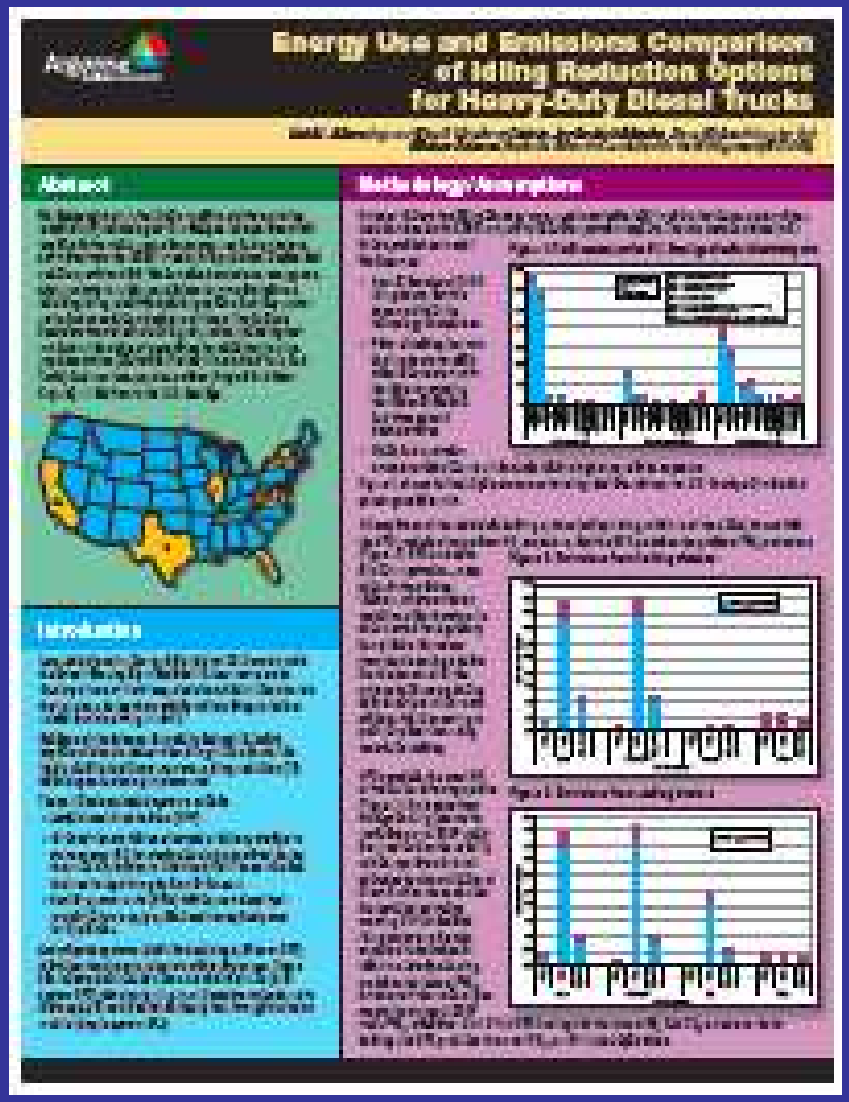
Truck Idling Reduction Analysis

- Analysis of full-fuel-cycle effects of idling reduction technologies. Presentation - Transportation Research Board Annual Meeting 01/09.
- Evaluate impacts at truck and upstream energy use. Emissions estimates from GREET model with climate and vehicle operation data.
- Compared emissions, energy use, and proximity to urban populations for nine alternatives, including idling, electrified parking spaces, auxiliary power units, and combinations.

Urban/Rural Locations

Results

(see attached pdf file)



Energy Use and Emissions Comparison of Idling Reduction Options for Heavy-Duty Diesel Trucks

4. Outreach

JMU SHENAIR Team / Valley AirNow
Tiffany Tumer, Chantel Phillips, Mathew Allen Brady, and Eric Firnhaber

NSVRC
Website, pamphlet

5. Valley AIRNow/SHENAIR Events

- **August 22, 2008 –**Distributed informational air quality materials to over 200 first-year K-12 teachers at the New Educators Breakfast—an event hosted by the Top of Virginia Regional Business Chamber.

- **September 23, 2008** - Hosted the Greater Shenandoah Valley Environmental Education Alliance meeting at James Madison University.

- **September - November 2008 –** Developed promotional flyers for its Healthy Air Zone and AIRCorps programs to disseminate to targeted businesses in the Northern Shenandoah Valley region.

- **October 4, 2008 –**Exhibited at the 1st annual Frederick County Sustainability Festival sponsored by the County of Frederick Parks & Recreation department. The focus of the booth that we staffed was the reduction of transportation energy use as a means to protect local air quality.

Upcoming Events

- **February 14, 2009 –** GLOBE Training Workshop for Girl Scouts of Shawnee Council troop leaders and senior girl scouts.
- **February 25, 2009 –** Presentation to Winchester Kiwanis Club.
- **March 2 - 5, 2009 –** National Air Quality Conference.
- **April 2 - 3, 2009 –** GLOBE Training Workshop for Page County K-12 teachers.

6. Air Quality Modeling

VT SHENAIR Team

Prof. Linsey Marr

Research Questions

1. How much of the Valley's air quality problem is due to locally generated emissions versus regionally transported pollution?

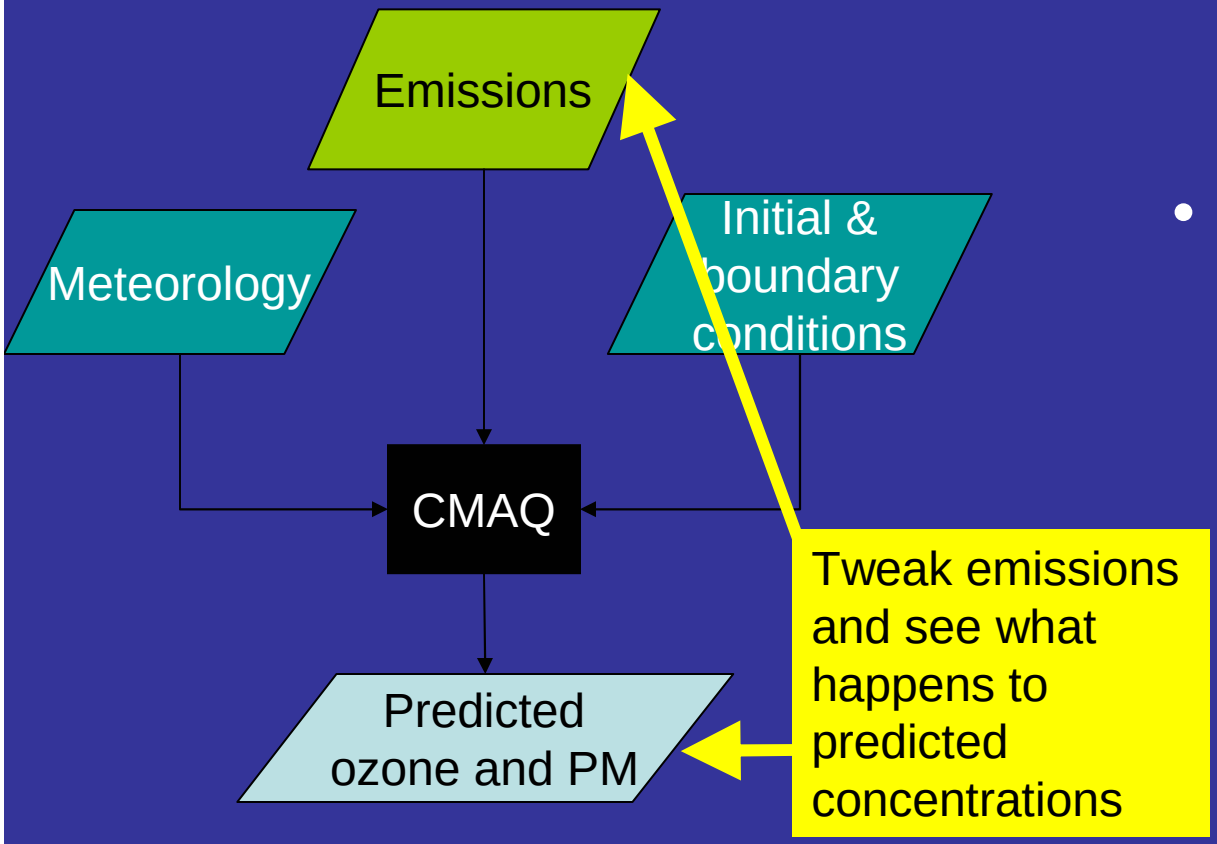
2. How can local government actions improve air quality in the valley?

Source Identification

- Air pollutant emissions assessment in the Shenandoah Valley.
- Emissions were assigned to one of 14 source categories and allocated by county or city.
- PM2.5 emissions were not dominated by any single source, but fuel combustion, dust, and agriculture were important contributors.
- Biogenic sources were responsible for 56% of the volatile organic compounds (VOCs) emitted in the valley.
  - VOCs are important because they, together with nitrogen oxides (NOx) react to form O3 in the presence of sunlight.
  - On-road and off-road mobile sources were the largest anthropogenic sources of VOCs as well as 63% of the NOx.

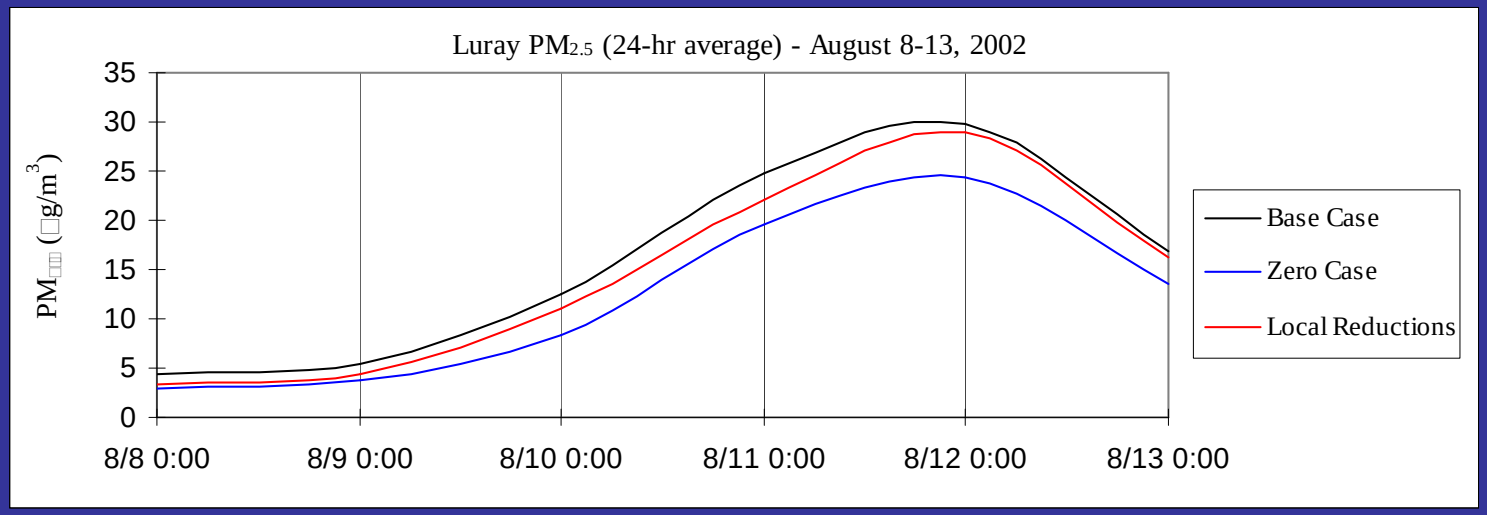
Methods

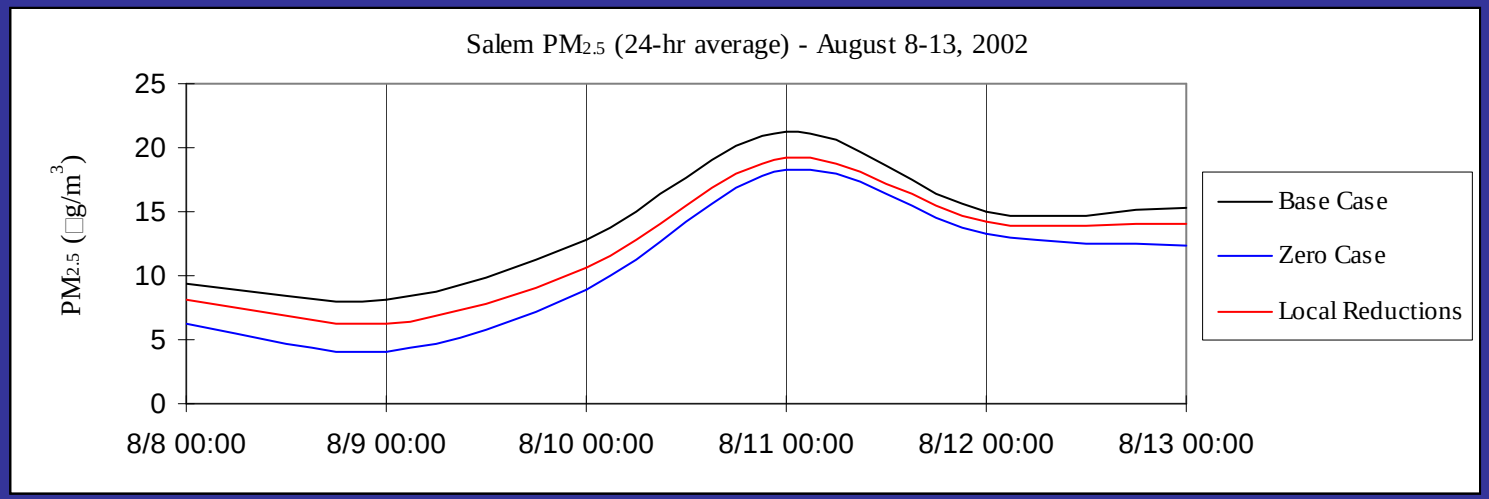
- 3D air quality model (CMAQ)



- Zero Case: "Turn off" anthropogenic emissions in the valley
- Local Reductions Case: Apply a combination of nine strategies to reduce emissions

$PM_{2.5}$ in August





Conclusions

- Reductions of emissions within the valley will improve $PM_{2.5}$ but not ozone.
- Improving ozone will require regional-scale cooperation.
- Local governmental actions have the potential to improve $PM_{2.5}$ and other health-related pollutants.

7. Completed

Final results previously reported:

- Monitoring: Rest monitoring station and Blandy Farm weather station
- Emergency responder pilot project
- GIS health analysis
- Science on a Sphere

Final results included in this presentation:

- Air quality modeling
- Idling reduction options for heavy-duty diesel trucks